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INFRARED ANALYSIS OF WASTES

TECHNOLOGY NEED

DOE has an inventory of 250 million kilograms of low-level nitrate salt waste and large inventories of other granular or powdered low-level mixed wastes. Presently, low-level mixed waste is immobilized by cementation, but cement-based processed waste cannot contain more than 20% (by weight) salt and still pass the Toxicity Characteristic Leaching Procedure (TCLP). In addition, certain waste chemistries affect the cement, preventing curing or causing expansion that bursts the waste containers. Polyethylene microencapsulation is an alternative promising waste immobilization technology being actively developed at Rocky Flats Environmental Technology Site. Polyethylene microencapsulation can produce a stable waste form containing up to 65% (by weight) waste.

Maintaining both proper immobilization and the highest possible waste loadings requires monitoring the process in real time. The project is using Transient Infrared Spectroscopy (TIRS) as the basis for an on-line, real-time composition monitor of the molten waste stream produced by the encapsulation process. The monitor provides data that will guide the waste process operators in their control of the encapsulation, will document the processed waste composition for certification purposes, and will provide a record of the processed waste should questions or problems later arise. Potentially, TIRS can also be applied to other waste processing operations, such as vitrification.

TECHNOLOGY DESCRIPTION

TIRS is a noncontact, on-line analysis technique for process streams of solid or viscous-liquid material. TIRS provides a real-time chemical (molecular) analysis of the process stream. Figure 2.3-1 shows how the TIRS monitor works. The surface of the molten encapsulated waste stream is cooled by a small air jet as it passes through the field of view of an infrared spectrometer. The stream radiates infrared by virtue of its high temperature. The alteration in the observed infrared spectrum caused by the cooling jet is used by the computer to derive the stream composition, or any other composition-related property. This project within the Mixed Waste Characterization, Treatment, and Disposal Focus Area (MWFA) applies TIRS to monitoring the waste loading in the encapsulated waste stream. Numerous on-site demonstrations of the technology involving several different wastes have been performed, during which a precision of better than 1% by weight was typically achieved. Figure 2.3-2 compares the TIRS analysis results with the known stream composition during one of those demonstrations. A TIRS monitor was built in FY96 for permanent installation at Rocky Flats, and personnel were trained in its operation.

BENEFITS

Polyethylene encapsulation produces a high quality waste form for long term storage or landfilling. The high waste loadings offer substantial cost savings, but the loading must be monitored to ensure the highest (i.e., most economical) loading consistent with proper immobilization. Without on-line monitoring, the waste loading cannot be strictly controlled and the target waste loading would have to be lowered to assure that it did not exceed the maximum allowed level. TIRS is the only technology that can provide on-line, real-time monitoring of the molten processed-waste stream composition. It does this automatically, without contacting the waste stream (except with air), so there is no secondary waste, no worker exposure, and little worker time required. The monitor log can also aid in waste certification, possibly reducing the amount of testing (e.g., TCLP) required.

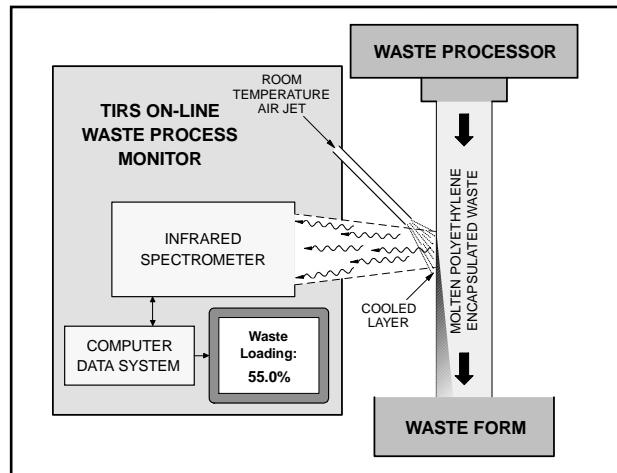


Figure 2.3-1 Schematic of the TIRS monitor on a waste encapsulation line.

COLLABORATION/TECHNOLOGY TRANSFER

In FY96 a TIRS monitor was permanently installed at Rocky Flats Environmental Technology Site, and personnel trained in its operation. In previous years, numerous demonstrations involving TIRS and polymer encapsulation, some of them public, were held at Brookhaven and Rocky Flats. In collaboration with Savannah River, we are exploring the application of TIRS to waste-vitrification monitoring. Plutonium and samarium in the vitrification glass produce distinct spectra, and appear to be monitorable. We are investigating the preliminary engineering necessary to apply TIRS to vitrification. TIRS was invented by the

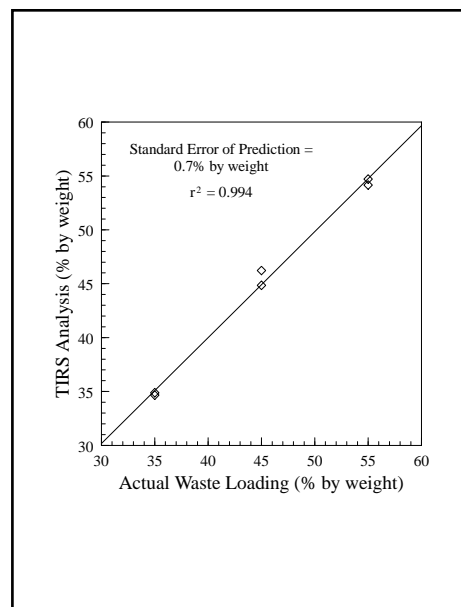


Figure 2.3-2 TIRS analysis compared to the actual loading of low-level nitrate-salt waste in an encapsulated-waste process stream.

principal investigator and is patented by Iowa State University. DOE and its contractors do not require a license to use TIRS, and licensing is available for others. Demonstrations of TIRS for other process applications have been conducted on manufacturers' process lines. Ames Laboratory and Iowa State University received a 1992 "R&D 100 Award" for TIRS.

ACCOMPLISHMENTS

- First hot test; on-site test of TIRS technology on an encapsulation line processing real low-level mixed waste, Rocky Flats, April 1995
- Public demonstrations of the polymer encapsulation and TIRS technologies, Rocky Flats, May 1995
- Successful on-site test on four different waste stream types (e.g., molten-salt oxidation waste, flyash), Rocky Flats, September 1995
- Delivery of a TIRS monitor to Rocky Flats for permanent installation, March 1996
- Training of Rocky Flats personnel in operation of TIRS monitor, April 1996

TTP INFORMATION

Infrared Analysis of Wastes technology development activities are funded under the following technical task plan (TTP):

TTP No. CH13C231 "Infrared Analysis of Wastes"

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